Comparative Parametric Study of Vierendeel Girder and Truss Girder for Single Track Railway Bridge

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Abstract - *The purpose of this paper is to optimize truss girder bridges and Vierendeel Girder Bridge with a span of 50 m and height of 7.5m railway loading with 8 panels. Later the bridges are compared according to the most important analysis outcome such as deflection, shear force, bending moment and weight of material. The analysis and design of single track bridge for modified broad gauge loading is done and further the optimization process is carried out. Principal of static analysis is applied keeping limit state design as its constraint. The optimization is carried by varying no. of panels by using Indian flat flange sections. In the present paper an effort has been made to use the method of actual wheel load application and to optimize the through truss bridges and vierendeel girder bridge with different Panels Analysis and design of these bridges is done using STAAD PRO-V8i (SS5) (finite element analysis) software*.

***Key Words* - Vierendeel Girder, optimization, truss girder, Pratt truss, deflection, warren.**

1. INTRODUCTION

For the mass communication over a passage or gap bridges are the structures which fulfill our needs. The bridges which are generally used to carry railway traffic are called railway bridges. Though there are number of different types of bridges, the need of little time consumption in its construction is very important. For this purpose the steel bridges are generally preferred. As steel is an essential part of modern bridges it is strong, can flex without fracturing and has long life. New grades of steel increase the economic advantages of steel, while ensuring that it meets the increasing demand of high performance. Early bridges were made of stone, wood and concrete. The arrival of the steam train in the mid-18th century ushered a new era in bridge design. A stronger material was needed as bridges were required to carry heavier loads over longer spans. Iron was first used to bridge the Tees River in England in 1741. By the 1880s, Steel had become a material of choice. Steel can be used to build bridges of any length because of its durability and ease of manufacture and maintenance.

As Railways are the backbone of Indian society. Different types of steel bridges for the railways can be constructed depending on the span and site conditions. Nowadays India has touched the sky-high limits by the development of monorail. But still, in the inter territory there is a need of steel railway bridges, For this usually truss girder superstructures is preferred, this is because the truss girder are the main load carrying members and the depth of these load carrying member can be varied according to the design.

The truss girder bridges are also called open web girder bridges or can also be summarised as lattice girder bridges. From most of truss girders, a Pratt truss type is used because in this type chords carry the bending moment in the form of direct tension or compression and verticals or struts carry shear force. For short and medium spans it is economical to use parallel chord trusses such as Warren truss, Pratt truss, Howe truss, etc. to minimise fabrication and erection costs. Especially for shorter spans the warren truss is more economical as it requires less material than either the Pratt or Howe trusses. However, for longer spans, a greater depth is required at the centre and variable depth trusses are adopted for economy.

2. METHODOLOGY

Collection of relevant research data from national and international journals, Technical magazines, reference books and through internet.

1. To study various components of Railway bridge with a case study of existing and proposed railway over bridge
2. To prepare model of girders in structural analysis software.
3. After the preparation of models loading condition and Boundary conditions are prescribed.
4. Then analyze the structure by using structural analysis software.
5. Conclusions will be drawn from results of analysis.

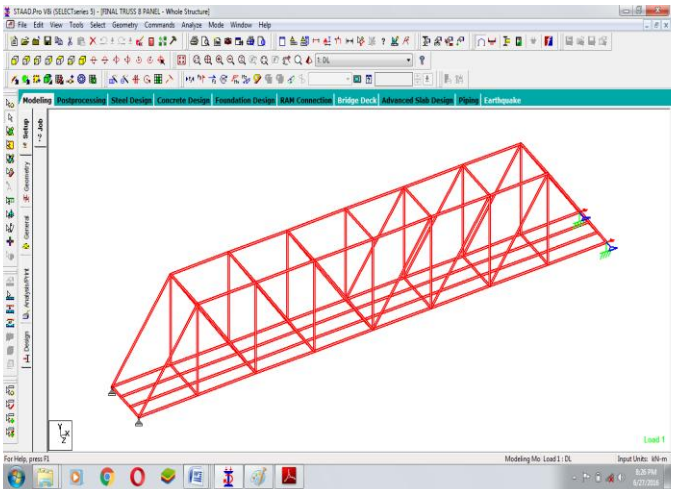

Fig -1: Truss Girder Bridge

3. ANALYSIS AND RESULT DISCUSSION

Modelling and Analysis of 50 m Single Lane Through Truss Railway Bridge and Vierendeel Girder Bridge (considered for project) using actual application wheel load is done. Creation and modification of the model, completion of analysis and optimization of the design with development of the output are all accomplished using this single interface. The scope of work is three fold

[1] To create model of a 50 m span Single Lane Through Truss Girder Bridge and Vierendeel Girder Bridge,

[2] The Optimization of both Bridge Superstructure is done for 8 panels,

[3] To Compare Weight and Deflection of the structure.

The first phase includes generating a Single Lane Through Truss Railway Bridge and Vierendeel Girder Bridge of 50 m span whose one end is hinged and other is roller. The width of girder is kept as 5 m for each passage of train and height of gider as 7.5 m Conforming To The Case Study and Bridge. The stringers are spaced at l.68 m after actual site visit. The distance between the stringer and the main girder is kept min of 1.66 m.

The second phase of model development includes the optimization of the same with 6 panel, 8 panel and 10 panel. During the optimization process, a different cross-section will be assigned to the top chord members, bottom chord members, diagonal members, vertical members, cross girders, and stringer members. Then the analysis and design is carried out till all the members remains safe and the required results are obtained using STAAD PRO V8i.

Case 1 : Establishment 8 Panel Truss Girder

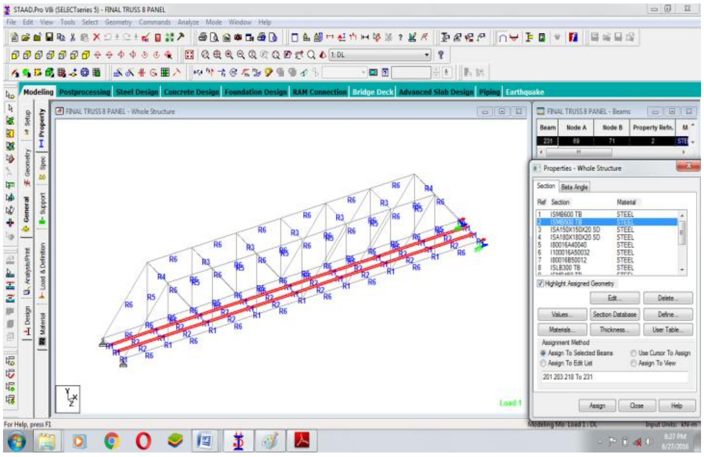

Fig 2-: Modelling Truss Girder Bridge

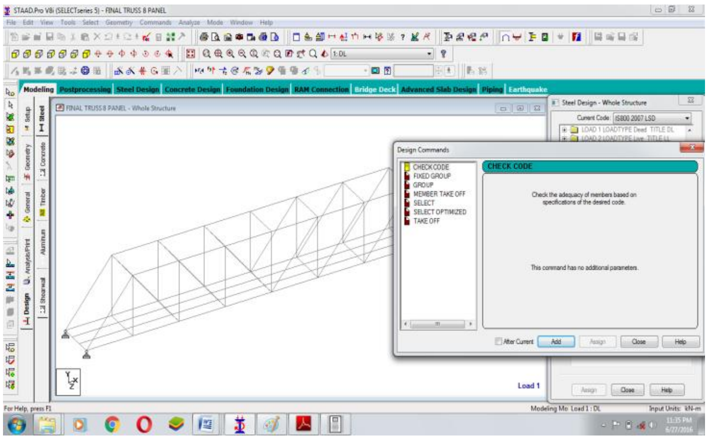

Fig -3: Analysis and Desihn Truss Girder Bridge

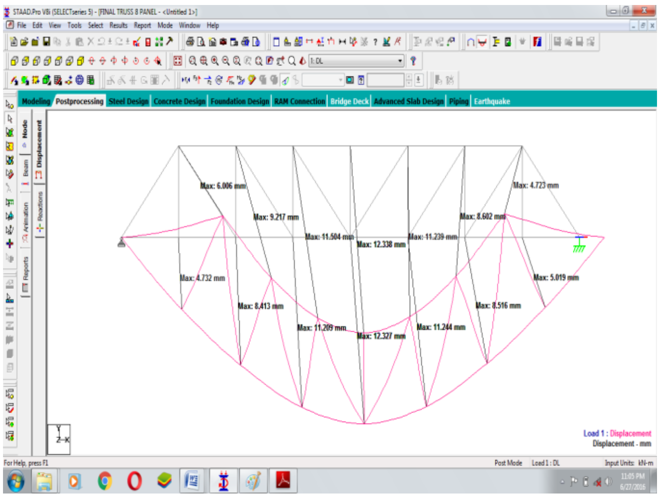

Fig 4: Displacement for Truss Girder

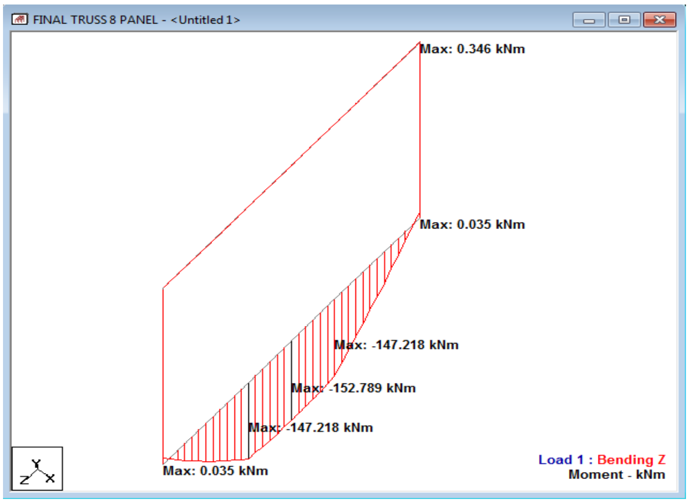

Fig 5 : Bending Moment for Truss Girder

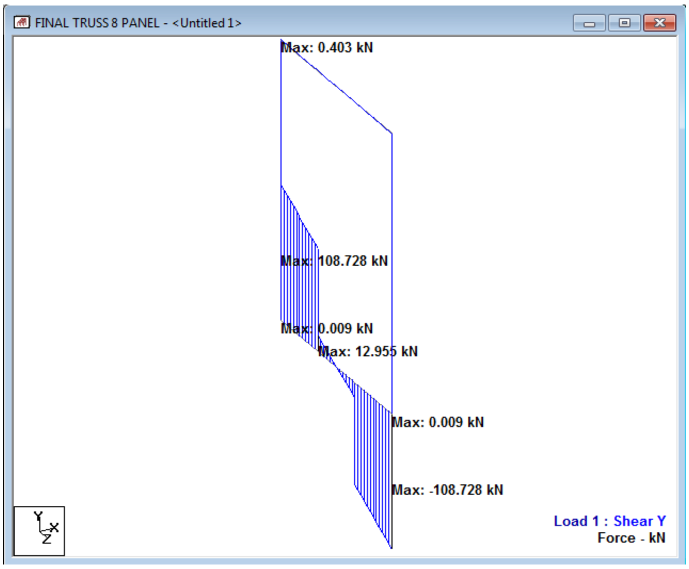

Fig 6 : Shear Force for Truss Girder

STEEL TAKE-OFF
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	PROFILE	LENGTH (METE)	WEIGHT (KN)
ST	I80016B50012	436.20	1404.029
TB	ISLB300	3.32	52.235
TB	ISMB450	16.60	266.811
TB	ISLB500	6.64	106.888
TB	ISLBP300	3.32	52.357
SD	ISA90x90x6	35.00	5.646
TB	ISLB75	15.12	233.198
TB	ISLB325	100.00	964.008
		TOTAL =	3085.172

Fig 7 STAAD Output Viewer for Truss Girder

Case 2: Establishment of 8 panel Vierendeel Girder

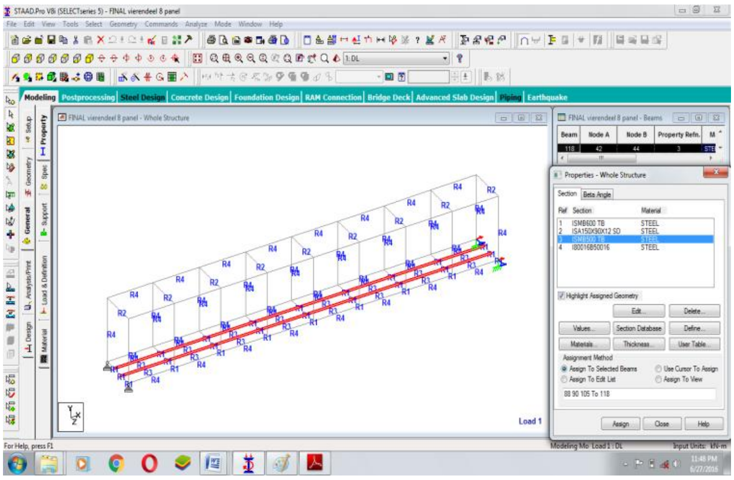

Fig 8 Modelling Vierendeel Girder Bridge

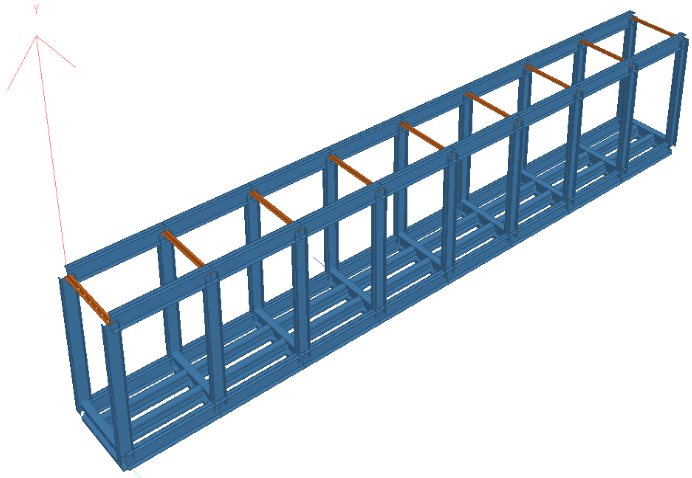

Fig 9 Rendered View of Vierendeel Girder Bridge

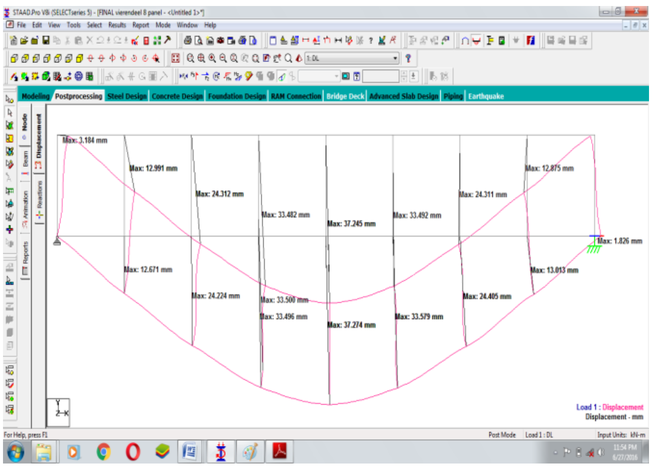

Fig 10 Displacement for Vierendeel Girder

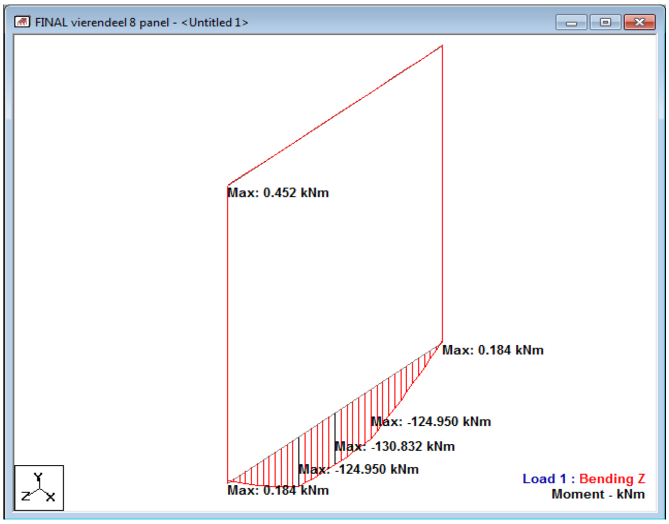

Fig 11 Bending Moments for Vierendeel Girder

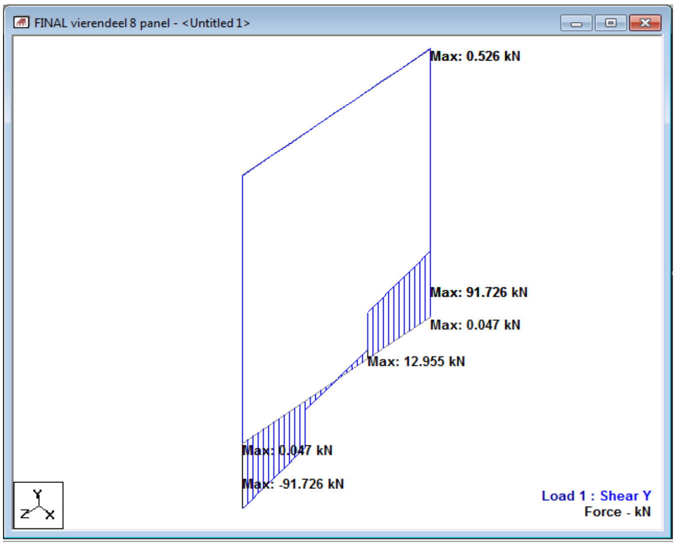

Fig 12 Shear Force for Vierendeel Girder

	PROFILE	LENGTH (METE)	WEIGHT (KN)
ST	I125016B50012	27.50	103.726
ST	I100016B50012	50.00	173.228
ST	I80016B50012	132.50	426.483
ST	I100016B50016	80.00	301.747
ST	I100016B50020	15.00	61.187
ST	I160016B50016	30.00	135.279
TB	ISLB350	3.32	52.615
TB	ISMB450	9.96	160.087
TB	ISLB500	6.64	106.888
TB	ISLB450	6.64	106.255
TB	ISMB350	3.32	52.709
SD	ISA90x90x6	45.00	7.259
TB	ISLB75	15.12	233.198
TB	ISLB350	87.50	848.952
TB	ISMB350	12.50	121.634
		TOTAL =	2891.245

Fig 13 STAAD Output Viewer for Vierendeel Girder

Discussion of Results

Following Results are obtained For 8 Panel Truss Girder and Vierendeel Girder

1.Displacement Results

Sr No.	Girder Type	Displacement in mm
1	Truss Girder	12.33
2	Vierendeel Girder	37.24

Therefore Displacement for Vierendeel Girder is 66.87 % more than truss girder for a given standard loading.

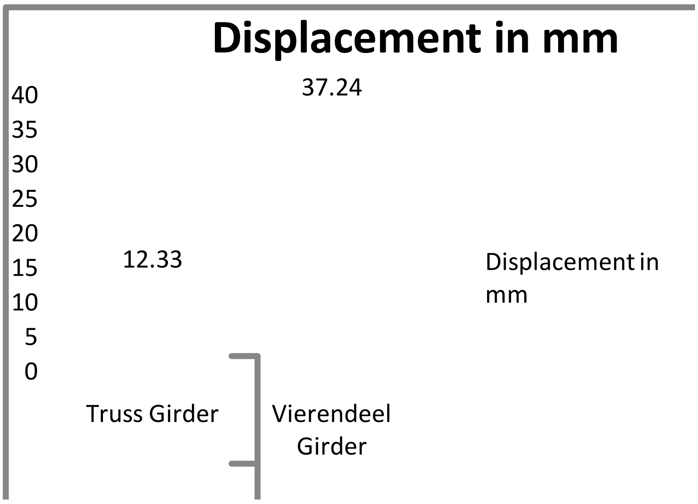

Fig 14 Final Displacement for 8 Panel Girder

2.Weight of Structure

Sr No.	Girder Type	Weight of Structure in kN
1	Truss Girder	3085.17
2	Vierendeel Girder	2891.24

Therefore Weight of Structure for Vierendeel Girder is 6.28 % less than truss girder for a given standard loading

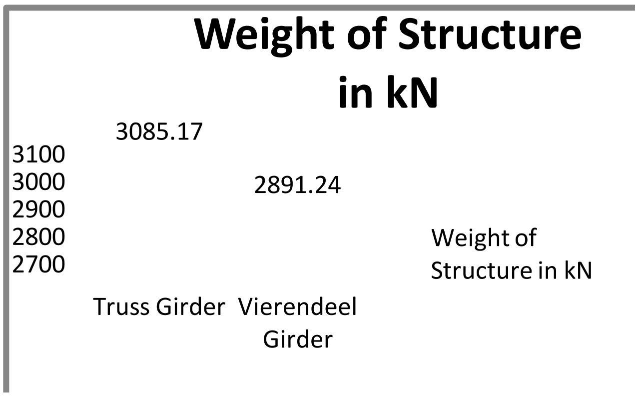

Fig 15 Final Weight of Structure for 8 Panel Girder

4. CONCLUSION

The main observations and conclusions drawn are summarized below:

1) An Uncommon Structure i.e. Vierendeel Girder is analysed and its various parameters are studied
2) Displacement is observed more in Vierendeel Girder and is increases as number of panels increases
3) Weight of Truss Girder is more than Vierendeel Girder and optimum weight is observed in 6 panels with 15% more than Vierendeel Girder.
4) In Vierendeel Girder joints are easy to construct as all members are joined perpendicularly whereas in case of Truss Girder Crowding of members takes place hence tedious job for installation.
5) Modifications and Maintenance is easy for Vierendeel Girder.

REFERENCES

1. A.S.Jamadar , H.S.Jadhav.(May 2015.) "*Optimization Of Double Track Railway Bridge Superstructure Using FEM"* International Journal Of Emerging Technology And Advanced Engineering, Volume 5.
2. Maraveas C, Papagiannakis A, Miamis K, Tasioulia K.(2014) "*Optimal Design Of Through Truss Steel Bridges*". The 2014 Intenational Conference On High Performance And Optimum Design Of Structures And Materials.
3. Jinkoo Kim And Jongyeol Park.(June 2014) *"Design Of Special Truss Moment Frames Considering Progressive Collapse"* International Journal Of Steel Structures, Vol 14, No 2, Page 1-13.
4. Sankar Midhun B, Jacob Priya A. (2013) "*Comparison Of Design Standards For Steel Railway Bridges*". International Journal Of Engineering Research And Applications, Page 115-189.April.
5. Prof. Kalid Shaker Mahmod, Aalaa Whaleed Hameed. (June 2008) *"Nonlinear Analysis Of Reinforced Fibrous Concrete Vierendeel Truss"* Journal Of Engineering, IASJ Number 2 Volume 14.
6. V.V.Shastri , Bridge Engineering , Dhanpatrai And Company,1st Edition, 2013.
7. D. Johnson Victor , Essentials Of Bridge Engineering, 6th Edition, Oxford & IBH Publishing Company Pvt Ltd. 2011.
8. Bridge rules (IN SI UNITS). Rules specifying the loads for design of super-structure and sub-structure of bridges and for assessment of the strength of existing bridges. Adopted-1941, second reprinting–2008.
9. Indian railway standard. Code of practice for the design of steel or wrought iron bridges carrying rail, road or pedestrian traffic. Adopted–1941,reprint-2003.
10. I. S. 1915-1961:The Indian standard code of practice of steel bridges.